SVD AUDIO WATERMARKING

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ABSTRACT

It proposes an approach for audio watermarking using the singular value decomposition (SVD) mathematical technique. After transforming it into a 2-D format the encrypted image is embedded in the singular values of the audio signal. After watermark embedding, the audio signal is transformed again into a 1-D format. For encrypt the image chaotic encryption is used. It improves the quality of extracted images as proved experimentally, where it resists the noise and different attacks.

KEYWORDS

SVD, watermarking, baker mapping, chaotic encryption, decryption, SVs (Singular Values)

1. INTRODUCTION

Digital Watermarking has found many applications in image, video and audio transmission. In audio watermarking algorithms most of them are designed to achieve an efficient detection of the watermark without extracting meaningful information from the watermarked audio signal designed to achieve an efficient detection of the watermark without extracting meaningful information from the watermarked audio signal [8-9]. There is a need for a robust audio watermarking approach with a higher degree of security, which can be achieved by embedding encrypted images in audio signals [8-9]. In this project, the chaotic Baker map is used for the encryption of the watermark image [1-3]. Then, the watermark is embedded in the audio signal using the SVD mathematical technique [1]. The audio signal is transformed into a 2-D format .The singular values (SVs) of the resulting 2-D matrix are used for watermark embedding. From the speech signal at the receiver end the water mark is extracted and then the watermark is decrypted to get the message.

2. SYSTEM IMPLEMENTATION

In this project the cover speech signal is converted to 2-D for SVD water marking, then the message to be transmitted is encrypted by using baker mapping version A [1-3], and watermarked the message into the 2-D changed cover signal using SVD technique [1]. Then for transmission it is again converted to 1D.

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At the receiver end the 1-D matrix is changed to 2-D for extracting watermark. The extracted watermark is decrypted to get the message, and then the result is compared with the original message. The block diagram is given in fig:2.1

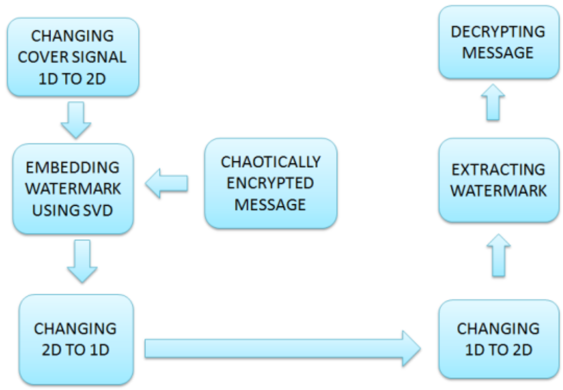


Fig 2.1 block diagram of system

To find out its response with noise, noise is added with the transmitted signal and the received message is compared with the original message using different signal to noise ratio.

2.1. SVD (SINGULAR VALUE DECOMPOSITION)

The Singular Value Decomposition decomposes the cover signal into 3 matrices each of size same as that of cover 2-D matrix [1].

SVD (Cover signal) = U S V’

Its singular value diagonal matrix is S of the cover signal, the encrypted message matrix is watermarked into the matrix S using a constant k=0.01, which makes the signal undistorted. And the watermarked matrix is again converted to 1-D for transmission.

2.2. BAKER MAPPING (ENCRYPTION)

Baker mapping encrypt the message block by block, which will be easy for decryption [2,3]. Here we uses version A baker mapping of 8X8 matrix. Version A baker mapping can be done by using 5 different keys. The key elements are selected according the following considerations

- The elements sum must be 8
- 1 is not taken as element
- 8/each element must be perfectly divisible

  The steps for baker mapping are given below
- Take 8*8 message matrix
- Encrypt the message using the equation

  $B(x', y') = A(\frac{N}{n_i}(x - N_i) + y \bmod \frac{N}{n_i}, \frac{n_i}{N}(y - y \bmod \frac{N}{n_i}) + N_i)$, Where N=8.
- B will be the baker mapped message

2.3. EMBEDDING WATERMARK USING SVD

The flowchart for embedding watermark is given in the figure 2.2. The audio signal is transformed into a 2-D format and the singular values (SVs) of the resulting 2-D matrix are used for watermark embedding. The chaotically encrypted message is embedded into the cover matrix using SVD method. And the 2-D matrix is transformed to 1-D

The steps for embedding a watermark using SVD method are given below

- The 1- D audio signal is transformed into a 2-D matrix (A matrix).
  The SVD is performed on the A matrix.
  $$A = U\,S\,V^T$$
- The watermark (W matrix) is added to the SVs of the original matrix.
  $$D = S + K\,W$$
- A small value of K of about 0.01 is required to keep the audio signal undistorted. The SVD is performed on the new modified matrix (D matrix
  $$D = U_W S_W V_W^T$$
- The watermarked signal in 2-D format (Aw matrix) is obtained using the modified matrix of SVs (Sw matrix).
  $$A_W = U\,S_W V^T$$

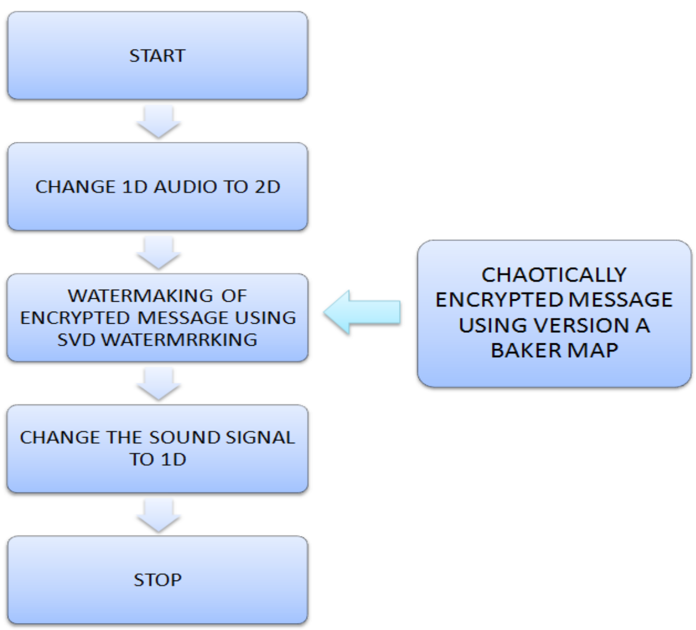


Fig:2.2 flowchart for embedding watermark

2.4. EXTRACTING WATERMARK

The flowchart for extracting watermark is given in the figure 2.3.The received 1-D is transformed to 2-D and the watermark is extracted. The watermark is decrypted to get the original message [1-3].

The steps for extracting watermark are

- The 2-D Aw matrix is transformed again into a 1-D audio signal.
- The SVD is performed on the possibly distorted watermarked image (A*w matrix).

$$A_W^* = U^* S_W^* V^{*T}$$

- The matrix that includes the watermark is computed.

$$D^* = U_W S_W^* V_W^T$$

- The possibly corrupted encrypted watermark is obtained.

$$W^* = (D^* - S)/K$$

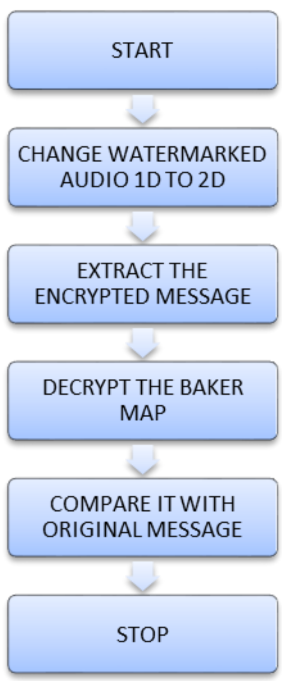


Fig.2.3 flowchart for extracting watermark

2.5. DECRYPTION OF BAKER MAP

- Take L=B'

- Use the following equation for decryption
  $K(x', y') = L(\frac{N}{n_i}(x - N_i) + y \bmod \frac{N}{n_i}, \frac{n_i}{N}(y - y \bmod \frac{N}{n_i}) + N_i))$, Where N=8,

- Take E=K', then E will be the decrypted message

The message before baker mapping is given in the fig:2.4 and after baker mapping is given in the fig :2.5.Then change the message matrix with the baker mapped matrix for embedding.

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

Fig: 2.4 message before baker mapping

1	9	17	25	2	10	18	26
33	41	49	57	34	42	50	58
3	11	19	27	4	12	20	28
35	43	51	59	36	44	52	60
5	13	6	14	7	15	8	16
21	29	22	30	23	31	24	32
37	45	38	46	39	47	40	48
53	61	54	62	55	63	56	64

Fig: 2.5 message after baker mapping using a key

3. RESULTS

Matlab software is used for simulation of the system which is explained in chapter 2. The cover signal required for system is 3 x 256 x 256 elements for transmission. For decryption we need U matrix and V matrix.256 x 256 U and 256 x 256 V is the watermarked matrix after SVD decomposition. They are embedded in to the cover signal. The encrypted matrix is embedded using SVD technique. The U and V matrix elements multiplied with 0.1 and added respectively with the elements of the cover signal. The cover signal is a sound signal and waveform of original sound is given in fig:3.1.

The message is of 8 x 8 size which is to be encrypted using baker mapping and watermarked using SVD to the above cover signal. The message example used is given in Fig: 3.2.The message is encrypted using baker mapping technique and the result will be like in figure fig:3.3 Then the encrypted message is watermarked into the cover signal using SVD method. And the U and V matrices are also added to the cover signal for decryption purpose. The resultant waveform of the water marked speech signal is given Fig: 3.4. The speech after watermarking makes no difference when played. And the waveforms also differ a little, which is hardly detectable. The extracted encrypted message from the watermarked sound wave is given in fig:3.5.

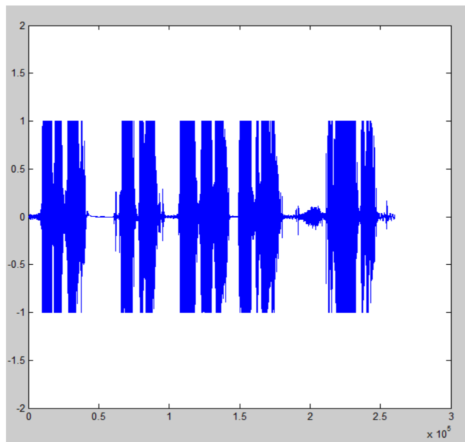


Fig: 3.1 waveform of original sound signal

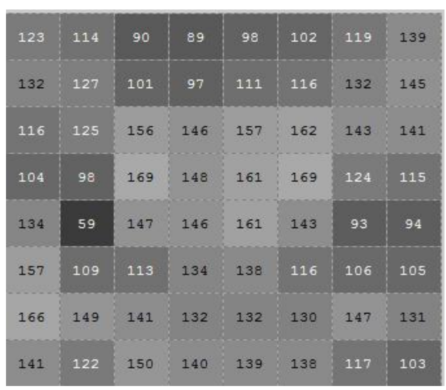
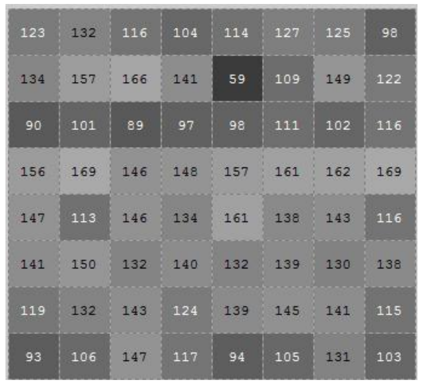


Fig: 3.2 message



123	132	116	104	114	127	125	98
134	157	166	141	59	109	149	122
90	101	89	97	98	111	102	116
156	169	146	148	157	161	162	169
147	113	146	134	161	138	143	116
141	150	132	140	132	139	130	138
119	132	143	124	139	145	141	115
93	106	147	117	94	105	131	103

Fig: 3.3 encrypted message

The U and V matrices are extracted from the received speech signal and by using the reverse operation in baker mapping the message is decrypted. The decrypted message is given Fig: 3.6 the decrypted watermark is same as the original message. Then for studying the performance of the system, watermarked speech signal is subjected to noise. And by varying the SNR from 0 to 50, the performance is evaluated for 64 elements. A graph is plotted verses SNR and error. SNR greater than 45 dB indicates no error and hence the signal is extracted. The error increases with decreasing SNR. The figure is given in fig:3.7

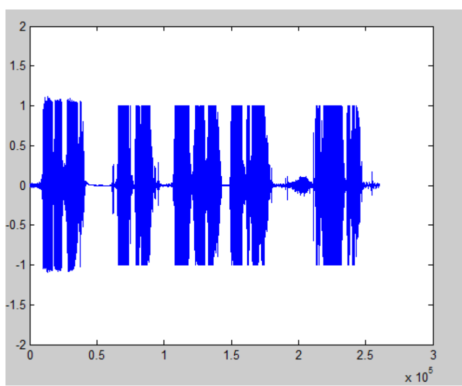
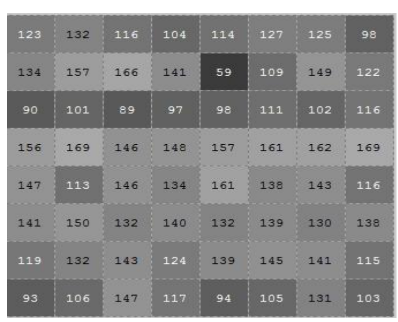


Fig: 3.4 waveform of watermarked audio signal



123	132	116	104	114	127	125	98
134	157	166	141	59	109	149	122
90	101	89	97	98	111	102	116
156	169	146	148	157	161	162	169
147	113	146	134	161	138	143	116
141	150	132	140	132	139	130	138
119	132	143	124	139	145	141	115
93	106	147	117	94	105	131	103

Fig: 3.5 extracted watermark from audio

123	114	90	89	98	102	119	139
132	127	101	97	111	116	132	145
116	125	156	146	157	162	143	141
104	98	169	148	161	169	124	115
134	59	147	146	161	143	93	94
157	109	113	134	138	116	106	105
166	149	141	132	132	130	147	131
141	122	150	140	139	138	117	103

Fig: 3.6 decrypted message

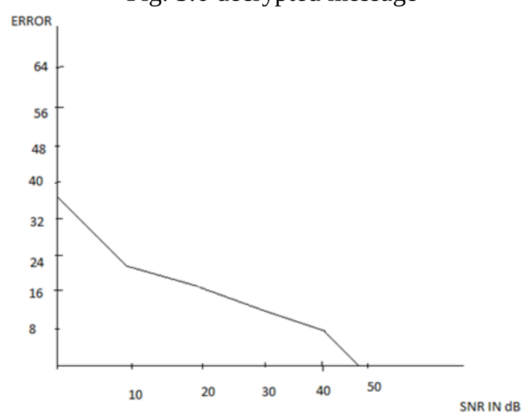


Fig 3.7 graph of SNR in dB against the error

3.1. ADVANTAGES AND DISADVANTAGES

The advantages and disadvantages of the SVD audio watermarking method are listed below
Advantages

- When SNR> 45 dB the received message has no errors.
- The encryption scheme used here is baker mapping which is more secure.
- The keys used for encryption are more secure which reduces Bruce-force guessing attacks.

Disadvantages

- Only 8x8 messages can be watermarked at a time, because encryption using baker mapping can be done for only 8X8 matrix at a time.
- The message length greater than 64 need to be cut into blocks of 64 elements.

4. CONCLUSION

This paper has presented an efficient security algorithm for Bluetooth network through SVD audio watermarking approach. In this algorithm, encrypted image is embedded as watermarks in audio signals to achieve a high degree of security. Experimental results have proved that watermark embedding in the proposed approach does not deteriorate the audio signals. It has been clear through experiments that the chaotic Baker map encryption algorithm is an efficient algorithm for watermark encryption.

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